# REPORT

OF

# THE SECRETARY OF WAR,

IN COMPLIANCE WITH

*A resolution of the Senate of the 16th of August last, calling for information respecting the ice-breaker and breakwater at the entrance of Delaware bay, the erection of a mole or pier opposite thereto, and a marine hospital at Lewistown; also for the construction of a breakwater on Crow shoal.*

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DECEMBER 18, 1856.—Read, referred to the Committee on Commerce, and ordered to be printed.

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WAR DEPARTMENT,
*Washington, December* 15, 1856.

SIR: In reply to the resolution of the Senate of the 16th August last, calling upon the Secretary of War "to communicate to the Senate at the commencement of the next session an estimate of the sums required for connecting the ice-breaker with the breakwater at the entrance of Delaware bay, and for erecting a stone mole or pier for landing at or near the fast land opposite the breakwater, and also for a marine hospital at Lewistown as an asylum for wrecked, sick, or distressed seamen, with the opinions of himself and of the chief engineer, of the advantage and necessity of said works, respectively; and that a similar estimate for a breakwater on Crow shoal, near Cape May, with the opinions of the same officers of the advantage and necessity of such a protection for the navigation and commerce of the United States, be communicated at the same time"—

I have the honor to transmit a report of the chief engineer, giving the information and estimates required in regard to connecting the ice-breaker with the breakwater at the entrance of Delaware bay, and for the construction of a breakwater on Crow shoal, near Cape May.

You will perceive from this report that there are no surveys in the department of the land opposite the breakwater, and consequently no estimate can be made, nor opinion given, as to the cost, advantages, or necessity of a "stone mole or pier for landing at or near" that place.

I also transmit a communication from the Secretary of the Treasury in answer to that part of the resolution relating to a marine hospital at Lewistown, it being a subject entirely under the supervision of his department.

Very respectfully, your obedient servant,

JEFF'N DAVIS,
*Secretary of War.*

Hon. J. D. BRIGHT,
*President pro tem. of the Senate.*

ENGINEER DEPARTMENT,
*Washington, December* 12, 1856.

SIR: I have the honor to acknowledge the reference to this office of Senate resolution of the 16th August last, calling for an estimate of the sums required for connecting the ice-breaker with the breakwater at the entrance of Delaware bay, and for constructing a breakwater on Crow shoal, near Cape May, with opinions of the Secretary of War and chief engineer as to the advantages and necessity for those works respectively.

In a report, dated October 8, 1853, Major J. G. Barnard, of the corps of engineers, submitted an estimate derived from a previous report made by Major Bache, of the topographical engineers, of the cost of connecting the ice-breaker and breakwater by continuing the latter, which estimate, amounting to $660,556, he considers sufficient for that object. He also submits two other estimates, derived from the same source, for covering the existing gap between the breakwater and ice-breaker—one, amounting to $924,262, for extending the ice-breaker beyond the line of the breakwater; and the other, amounting to $1,068,585, for a detached work to cover the opening.

Extracts from this report of Major Barnard are submitted herewith, in which are set forth, in much detail, the advantages and necessity of further protection to the harbor formed by the breakwater, either by carrying out the plan specified in the resolution of the Senate, or by one or the other of those mentioned above.

The use made of the breakwater harbor by vessels passing in and out of the Delaware, as well as by those engaged in the general coasting trade, which seek it as a harbor of refuge, conclusively shows its advantages to the commerce of the country; and the over-crowded condition of the harbor on the approach and during the continuance of storms, as convincingly shows the necessity for increasing its capacity to afford safe shelter even to our present commercial marine. With an enlargement of the accommodations for vessels, there is no doubt it would be still more resorted to by our constantly increasing commerce, as vessels would then be sure of finding shelter, which the present contracted limits of the harbor do not afford. In the condition in which it now is, the only safe anchorage in all storms is directly under the lee of the main work, whilst a large portion of the available space is lost in certain winds on account of the heavy sea that rolls through the gap between it and the ice-breaker. By covering this space, according to either of the projects before mentioned, this danger will be obviated, and a large anchorage ground, now in a great degree unavailable, will be secured, and the advantages proposed in the construction of the work obtained.

The choice between these different modes of accomplishing the same object depends, in a great degree, on the effect which each will have on the harbor. Either must, to some extent, derange the existing currents of the tides, and more or less affect the depth of water by new abrasions of the bottom, by deposites, or both. This action it is impossible to foretell without minute examinations and comparisons made on the spot; but they are of so great importance that they should

be carefully made before any work is undertaken towards modifying the present plan. I would therefore earnestly recommend that any appropriation by Congress toward the extension of the present work be so worded as to apply to such plan as a careful examination may show to be the most feasible.

All the information in this office relating to the proposed breakwater on Crow shoal, near Cape May, was furnished to the department in my report of April 26, 1856, a copy of which is sent herewith.

I am unable to furnish an estimate of the cost, or give an opinion as to the advantages and necessity of "a stone mole or pier for landing at or near the fast land opposite the breakwater," there being no surveys in this office giving the form of the shore, the nature of the bottom, with reference to its suitableness for foundations, or the distance to which it would have to be extended from the shore in order to reach a sufficient depth—on all of which the position and cost of the work would materially depend.

The resolution of the Senate is returned herewith.

I have the honor to be, very respectfully, sir, your obedient servant,

JOSEPH G. TOTTEN,
*Brevet Brigadier General, and Colonel Engineers.*

Hon. JEFFERSON DAVIS,
*Secretary of War.*

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ENGINEER DEPARTMENT,
*Washington, April* 26, 1856.

SIR: In answer to the letter of the 24th instant, from the chairman of the House Committee on Commerce, referred by you to this office, I have the honor to report that as the only information in the possession of this department in relation to a proposed breakwater on Crow shoal, Delaware bay, is that furnished by Major Bache's report, dated December 1, 1837, to be found in report No. 1050 of reports of House committees, twenty-fifth Congress, second session, volume 4, which gives only the gross estimated cost, I am unable to supply an estimate as to the amount of money that could be profitably expended thereon during the ensuing year.

In this want of precise knowledge, I suggest that the grants to the similar works on the other side of the bay—namely, to the Delaware breakwater—at its commencement and while in hand, may afford a basis for an appropriation for the contemplated work.

| | | | | |
|---|---|---|---|---|
| I find that in 1828 to commence the work there was granted | | | | $250,000 |
| 1830 to continue | do | do | do | 162,000 |
| 1831 | do | do | do | 208,000 |
| 1832 | do | do | do | 270,000 |
| 1833 | do | do | do | 270,000 |
| 1834 | do | do | do | 270,000 |
| 1835 | do | do | do | 100,000 |

1836 to continue the work there was granted... $100,000
1837.....do.....do.....do..... 141,000
And in 1838.....do.....do.....do..... 150,000

The letter of the Hon. Mr. Washburne is returned herewith.

I have, &c.,

JOS. G. TOTTEN,
*Brevet Brigadier General, and Colonel of Engineers.*

Hon. JEFFERSON DAVIS, *Secretary of War.*

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TREASURY DEPARTMENT,
*December* 6, 1856.

SIR: I have had the honor to receive your letter of the 4th instant, enclosing a resolution of the Senate of the 16th August, 1856, which calls on you to furnish estimates of the expense of certain work therein named at the Delaware breakwater, and also for a marine hospital at Lewistown, as an asylum for wrecked, sick, or disabled seamen; and inasmuch as marine hospitals are under the charge of this department, you ask me to transmit to you the information required in respect to the one proposed, in order that it may be transmitted (with your report) under the resolution.

In compliance with your request, I have to say, that the cost of erecting a fire-proof building, for a marine hospital of medium size, is estimated at $40,000, in addition to the cost of the ground, and the usual allowance of ten per cent. for contingencies.

But in giving this estimate as required by the resolution, and in compliance with your request, it is proper for me to say, that I do not concur in the propriety of constructing a marine hospital at the place and for the purposes mentioned.

Marine hospitals, as at present established, are for the temporary relief of sick and disabled seamen, and their proper positions are at the places of departing and incoming commerce, rather than on the line where, by the maritime law, seamen becoming sick are a charge upon the vessel in which they are employed.

To establish a hospital at the breakwater, where wrecks are apt to happen, and as an asylum for wrecked seamen, would constitute a new and different line of policy from that hitherto observed, and would necessarily be followed by demands for like asylums at a variety of other points on the coast.

The resolution is returned.

I am, very respectfully,

JAMES GUTHRIE,
*Secretary of the Treasury.*

Hon. JEFFERSON DAVIS, *Secretary of War.*

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OFFICE OF THE DELAWARE BREAKWATER,
*Philadelphia, October* 8, 1853.

SIR: I have the honor to submit the following reports on the different works under my charge for the year ending September 30:

*Delaware breakwater.*—Since the session of 1837–'38, no appropriation has been made to continue the construction of the Delaware breakwater until the close of the session of 1851–'52, when the small sum of $30,000 was appropriated to that object.

The last stone was deposited on the work, under former appropriations, in the year 1839, and since that date a work costing already nearly two millions of dollars—a work in every sense a "national" one—has remained in its half-finished condition, exposed to the injuries incidental to such a condition, at a period when its usefulness and the necessity of its completion were most amply demonstrated.

The vast advantages of such a work to commerce and its appreciation by navigation could not have been more clearly manifested, than by the following statement of vessels taking shelter under it up to that date:

| Years. | Ships. | Brigs. | Sch'rs. | Sloops. | P. Boats. | Total. | Remarks. |
|---|---|---|---|---|---|---|---|
| 1833.... | 22 | 178 | 372 | 167 | 127 | 866 | From Sept. 1, inclusive. |
| 1834.... | 48 | 315 | 667 | 303 | 411 | 1,744 | July 1, to October 17, not recorded. |
| 1835.... | 133 | 569 | 1,719 | 461 | 644 | 3,526 | |
| 1836.... | 301 | 1,027 | 2,719 | 620 | 767 | 5,434 | |
| 1837.... | 227 | 478 | 2,777 | 629 | 732 | 4,843 | |
| 1838.... | 165 | 732 | 3,191 | 765 | 685 | 5,538 | |
| 1839.... | 165 | 504 | 3,561 | 734 | 697 | 5,661 | |
| Total... | 1,061 | 3,803 | 15,006 | 3,679 | 4,063 | 27,612 | |

The table gives the number of *days' shelter* for each class of vessels during the period specified. It goes back to the period of the first emergence of the structure from beneath the waves, and comprises the term of its approach to its present condition. By the constant and gradual increase of the number of vessels, it shows how steadily, as its effective dimensions increased, it rose in the estimation of ship-masters.

The ten subsequent years, though the work remained as before stated in its incomplete state, and but inadequately fulfilled its objects, fully confirm the assumption of its constantly increasing value to the commerce of the nation.

| Years. | Ships. | Brigs. | Sch'rs. | Sloops. | P. Boats. | Total. | Remarks. |
|---|---|---|---|---|---|---|---|
| 1840.... | 172 | 279 | 1,909 | 308 | 371 | 3,093 | To June 3, inclusive. |
| 1841.... | 111 | 902 | 3,916 | 590 | 483 | 6,002 | From May 1, inclusive. |
| 1842.... | 107 | 1,060 | 5,335 | 802 | 794 | 8,098 | |
| 1843.... | 103 | 841 | 4,981 | 1,167 | 792 | 7,884 | |
| 1844.... | 231 | 969 | 5,797 | 854 | 744 | 8,595 | |
| 1845.... | 265 | 1,042 | 5,446 | 597 | 776 | 8,126 | |
| 1846.... | 258 | 1,625 | 6,711 | 614 | 781 | 9,989 | |
| 1847.... | 342 | 1,937 | 7,742 | 358 | 874 | 11,253 | |
| 1848.... | 340 | 1,457 | 6,037 | 374 | 918 | 9,126 | |
| 1849... | 329 | 804 | 3,261 | 168 | 553 | 5,115 | To May 30, inclusive. |
| Total... | 2,258 | 10,916 | 51,135 | 5,832 | 7,078 | 77,227 | |

It will be seen from the above, that (making due allowance for the periods in which no records were kept,) twenty-five vessels on an average have been lying in the harbor each day of these ten years.

No records have been kept since 1849 for want of means to pay for procuring the information; but it is notorious that the number of vessels has been constantly increasing, until it has become so great that during every severe northeasterly gale, more vessels arrive than can possibly find shelter; and after crowding all the sheltered space to a degree utterly inconsistant with safety, many are obliged to ride out the storm in situations quite out of the very limited shelter afforded by the breakwater, and many losses have occurred in consequence.

The General Taylor, a large schooner of 300 tons, through this cause, foundered at her moorings, and many similar instances could be cited.

Over two hundred sail have been counted at one time in the harbor, which does not now afford adequate protection for half that number, and it is quite an ordinary occurrence to see upwards of one hundred at one time.

During a portion of the time during which records were kept—viz: from January 16, 1838, to October 16, 1839—all vessels bound coastwise were distinguished from those sailing to or from the Delaware. This classification was intended to show the relative advantage of the harbor to the local trade, and to that of the country at large. Within the twenty-one months just mentioned, shelter to 3,877 vessels was afforded to vessels bound along the coast, being about two-fifths of the whole number. Excluding the pilot boats, the proportion extends to four-ninths. In other words, the benefits of the harbor to local trade and general commerce were in the ratio of five to four. Assuming that the same ratio now exists, this does not give a fair view of the importance of the work in a strictly national sense. Neither Pennsylvania, New Jersey, nor Delaware, are, except to a limited extent, ship-building or ship-owning States; and of the vessels engaged in trading out of the Delaware to other ports, three-fourths may be safely set down as owned in New England or New York. One feature in this so-called local trade is of national interest, viz: the coal trade. The vast amounts which are annually supplied to every part of the country, and particularly to New York and Boston, employ a number of vessels sufficient in itself to fill the breakwater harbor in its now inadequate state.

The vessels engaged in this trade are almost exclusively built and owned at the east.

It is intended to give some statistics of this trade, if possible to procure them in time for this report.

For another reason, the ratio above given does not adequately represent the importance of the harbor as a *harbor of refuge* to the general commerce.

A very large proportion of the whole number of vessels bound into and out of the Delaware cast anchor in the harbor merely to await a favorable wind to proceed. These are all recorded in the number making up the local trade. But let a threatening sky foretell the approaching storm, and a few hours will suffice to fill a previously

vacant harbor; let a northeasterly storm continue a day or two with severity, and the harbor becomes crowded almost beyond its capacity. The fleet of vessels which now fill it are seen to come in, in rapid succession, from the seaward, and there is no single fact more capable of impressing on the mind the magnitude of our coasting trade than the great number of vessels which a few hours time will, under the above circumstances, congregate at this point. I repeat, and emphatically urge, the fact that, as a *harbor of refuge*, for which it was designed, it is in no sense a work of mere local interest. It was constructed for, and is resorted to by, the floating commerce of the *nation*, and in this light only it should be regarded. It has been the means of saving millions of property and countless lives from destruction—property whose owners or underwriters are as widely distributed as are the merchants and ship-owners of the nation; and lives whose preservation is a duty which a nation owes to humanity.

I have thus emphatically set forth the purely national character of this great work, from the fact that for fifteen years every effort to procure from Congress the means for its completion has been defeated by its being associated with local objects. No constitutional scruples as to the expediency of internal improvements, as they are now entertained even by the most rigid constructionists, apply to this work, and there has always been a disposition with the Executive, as well as with both houses of Congress, to complete it; but, unfortunately, by being comprehended in a general appropriation bill, it has been made to share the fate of projects of a more doubtful character.

But two other works of the same character have been undertaken in modern times on a scale commensurate with this; and these have been undertaken by the two great naval and commercial powers of Europe, and carried to completion. France boasts of her breakwater at Cherbourg as one of the most stupendous undertakings of modern times; while England points with pride to that of Plymouth, as only second in magnitude to that of her great rival.

The Delaware breakwater, though inferior in extent and vastness of conception to that at Cherbourg, may be ranked with that at Plymouth, to which, in mere linear dimensions, (when it shall have been completed,) it is indeed superior; and it further differs from the above-cited works, that whereas *they* were mainly undertaken in reference to the *naval* aggrandizement of the respective nations, the Delaware breakwater was designed solely for the benefit of trade and commerce and the preservation of life. Under this point of view it has a higher claim to the regard of a government like ours, whose first great object is to promote the general welfare of all its citizens, than if undertaken under the prompting of national vanity for national aggrandizement. Political interests or moneyed interests find everywhere ready exponents; and if the Delaware breakwater depended on them alone, it would only be necessary to prove that those interests were general and national, and not individual or local. But there is another interest, which is, in general, voiceless—that interest concerns the comfort and preservation of life of our sea-fairing community. That portion of our citizens who, by association with those who resort to this harbor, know the interest which that class feel and manifest in this work, and

know that while it concerns merely the preservation of others' property, it concerns their personal comfort and safety, will appreciate the motive which induces me to appeal to the councils of the nation to complete *this work*, whatever may be the fate of others of less general interest.

"The commissioners who were appointed under the act of Congress of the 24th of May, 1828, to ascertain the most eligible site, and to prepare plans and estimates for a harbor near the mouth of Delaware bay, in their report of the 2d February, 1829, selected Cape Henlopen. They said 'the objects to be gained by an artificial harbor in this roadstead are to shelter vessels from the action of the waves caused by the winds blowing from east to northwest, round by the north, and also to protect them against injuries arising from floating ice descending from the northwest.' Having these objects in view, the commissioners proposed two works—the breakwater proper to secure the first object, and the ice-breaker, an auxiliary to the breakwater, but chiefly to accomplish the second purpose. The first-mentioned work was designed with a length of 1,200 yards, and on a course N. N. W. drawn from the pitch of the capes. The ice-breaker was designed with a length of 500 yards, on a course W. by S. $\frac{1}{2}$ S., and so placed that the line of the breakwater produced should cut off 272 yards towards the sea. The design further required an entrance between the sea end of the breakwater and the 24 feet curve of depth at the cape of 500 yards, and between the two works of 350 yards.

"These works have not yet been completed to the extent of the design thus briefly described. The breakwater is in a course of construction for 862 yards, and the ice-breaker for 467 yards. In other respects, the design of the harbor is necessarily incomplete. The entrances at the cape and between the two works are 780 yards and 455 yards, respectively, instead of 500 yards and 350 yards, as at first contemplated. It would thus appear that, on the one hand, the breakwater proper is 338 yards, and the ice-breaker 33 yards less; and on the other, that the entrance towards the sea is 280 yards, and that between the works 105 yards greater than the plan called for. In short, the lines of protection are less, and the entrances greater, by the quantities just given than was originally designed.

"During the progress of the work, as early as 1831, the customary surveys at the close of the operations of the season showed that deposites were forming about the works, and among these, one just within and near the western end of the breakwater. These, however, were to so small an extent as not to attract much attention until 1834. In the autumn of that year, they were found to have increased so much as to cause serious anxiety respecting the ultimate usefulness of the harbor. When these facts were made known to the War Department, it ordered a board of survey to examine and report upon the subject. The report of the board is dated the 10th of November, 1834, and closes in substance with the following opinions:

"1. That future operations should be confined to giving to the works the ultimate dimensions on their then present basis.

"2. That in the mean time numerous and careful surveys should be made to determine with exactness the increase of the shoals, and

that a system of observations should be pursued as to the force and directions of the currents; and

"3. That it would be premature, without a knowledge of the facts called for under the second head, to modify the original project.

"The course recommended by the board was, without doubt, adopted for guidance in future operations.

"The annual reports upon the work from 1835 to 1839 inclusive, with the exception of that for 1838, distinctly state that neither work was extended during those years. Since 1839, as heretofore observed, all operations for continuing the works have, owing to a want of funds, been suspended. A comparison of the lengths of the works as now existing with those given in the annual report of 1833, confirms the opinion that the recommendation of the board on this point governed the operations. The length of the breakwater is almost identical; and any increase since that year in the length of the ice-breaker may be attributed to the necessity which from time to time existed for fortifying, by additional deposites, the east end of that work, which from its exposed position was liable to disruption.

"The records of the office do not show that the measures which were recommended for ascertaining the enlargement of the shoals referred to were very satisfactorily pursued. It is true that surveys were made in 1834, 1835, 1836, 1840, and 1842; but, with the exception of that of 1842, these were almost wholly confined to a delineation of the bottom, and were on this point, owing to the want of knowledge of the plane of reference, used in each case in the reduction of the soundings. No satisfactory comparison can be made, so as to arrive at any definite conclusion with regard to the increase of shoals. Referring only to the shoal at the west end of the breakwater proper, (the only one from which any evil effects have arisen,) all that can with certainty be gathered from a comparison of the surveys is, that from the date of the first up to the examinations in 1842 it has gradually increased. Some reasonable conclusions might be arrived at if, with a statement of the order in which stone was deposited, information as to the rate of increase, or as to the time at which the shoal was at its maximum, had been given; but the surveys do not give this data."*

The small amount of the recent appropriation, together with numerous other demands upon the time of the engineer, has made it impracticable to determine the present condition of these shoals; but the universal testimony is, that no observable change has taken place since the survey of 1842, and it is reasonable to believe that the harbor has accommodated itself to its new regimen, and no further increase of the shoal need be feared.

The harbor, even in its present state, has answered, to a certain extent, the purpose of its original design, and the results prove the wisdom of the undertaking and justify the large expenditure that has been made on it. "Nevertheless it must be conceded that all that was anticipated from it has not been obtained. Its object was to 'shelter vessels from the action of waves caused by the winds blowing

* Extracted from Major Bache's annual report, October 15, 1843.

from east to northwest, round by the north ; and also to protect them against injuries arising from floating ice descending from the northwest.' The roll of the sea raised by the winds, particularly by the east-northeast winds, which enters the gaps, and particularly that between the two works, exposes vessels lying in the harbor to considerable inconvenience, and also to great hazard. The only position secure from the roll of the sea is immediately under the lee of the principal work, and it happens that this position, from the force of the ebb current, is the furthest removed from the effects of floating ice. Consequently, vessels in the harbor crowd to that point, and as they occupy a very limited space, are in danger of being injured by each other at every drift of the wind and tide. But even from this refuge, imperfect as it is, vessels of the largest class are excluded, owing to the shallowness of the water. Nor does the harbor afford the security against floating ice, which was contemplated by the original design. Not only are vessels exposed to the ordinary inconvenience and risk attendant upon running ice, but there have been instances in which the whole fleet occupying the harbor have been at once carried out to sea by the floating masses.

"To what extent these defects in the harbor are attributable to the nature of the original design, or to the unfinished state of the works, it seems to be useless now to consider, unless with a view to a suitable remedy. As heretofore intimated, the further extension of the works was discreetly abandoned as soon as the shoal formations in the harbor were discovered. This course was especially prudent in relation to the breakwater proper, as its influence in causing the shoal in its immediate vicinity could not be doubted even at that early period. It was also proper to postpone any modification of the design until the works, as they were, should be raised to their ultimate height, and until further information in relation to the shoal formations should be obtained, which might, it was supposed, have a controlling influence over the measure. The works have now nearly obtained this elevation ; a single season will be sufficient for their completion. And although the information obtained may not be of a character that should give it value in elucidating the subject of the formation of shoals generally, it is sufficient to show, in contemplation of such a purpose, that the shoals in question are distinctly attributable to the existing works. The moment has arrived when, if it is intended to consummate the design originally entertained for establishing a safe harbor at Cape Henlopen, suitable means should be adopted to carry into effect the measures indicated by the board of survey in the last resort, namely, a modification of the plan of the harbor. It is with a view to some proceedings of this kind that the undersigned, in the preceding remarks, has invited attention to the subject, and that he now begs leave to lay before the bureau, with such remarks and explanatory observations as the occasion calls for, the several propositions that have been made for so modifying the harbor as to remedy its present defects.

"In order to remedy the defects of the harbor, which are caused by the rolling of the sea entering between the works, three modes have been suggested :

"1. To cover the gap by extending the ice-breaker;
"2. To close the gap by extending the breakwater proper; and
"3. To cover the gap by a detached work."*

It forms no part of my present design to discuss the merits or demerits of these different projects.

They have been fully set forth in sundry reports now on file in the Engineer Department; among which I would allude to a report of Major Delafield, in favor of the first (his annual report for 1836); to a report of Lieutenant Linnard, advocating the second, of November 13, 1839; to reports of Major Bache, of September 16, 1839, and of October 15, 1843, in which all the different projects are discussed, and a preference given to the third.

Differing as they do as to the particular remedy, they all agree that the most serious defect in the harbor under the original design arises from the heavy sea which enters by the gap between the two works, and as to the necessity of either closing or covering this gap. The testimony of all who are acquainted with the work at the present date, is in accordance with their views on these points. Probably one half of the otherwise available harbor room is destroyed by this gap.

In estimating for the continuance of the work, therefore, it may be safely assumed that the original plans must be so far modified as to close or cover this gap by one of the three projects enumerated. Major Bache, in his report of October 15, 1843, has carefully estimated for the *completion* of the work under each of the three several plans. His estimates are founded upon the data furnished by the previous history of and experience gained at the work, all of which is set forth with great detail. It is believed that stone for the work may be obtained at the present date as cheap or even at lower prices than he estimated in 1843; and though labor has risen, it is not thought necessary to alter his estimates.

These estimates are as follows:

| | |
|---|---|
| For covering the gap by extending the ice-breaker..... | $815,341 00 |
| For closing the gap by extending the breakwater proper | 551,635 00 |
| For covering the gap by a detached work..... | 959,664 00 |

To these must be added, severally, the sum of $108,921 (equal to his estimate of $138,921, minus $30,000 since expended) for raising the existing works to their proper level, and for filling holes in the bottom at their ends. This would make the total sum required for completion $660,556 on the least costly, and $1,068,585 on the most costly project.

All these projects, however, contemplate an adherence to the original profile of the work. I believe it may be modified with great advantages and with great economy.

In designing the work the commissioners had but two precedents before them—the Cherbourg and Plymouth breakwaters. The slopes were blindly copied from the first, and it seems to have been considered a bold step to reduce the width at the top from 30 feet (that of the Plymouth) to 22 feet.

* Extracted from Major Bache's annual report, October 15, 1843.

I consider the profile and the principles upon which it is based radically vicious. They are to trust to the isolated mass of each block of stone, exposed on the surface, to retain its position, while at the same time an accumulated mass is heaped up twice as great as necessary to resist the accumulated effort of the waves.

The practice in construction has indeed outdone the commissioners in applying these principles to the construction of the work, for little attention has been paid to their recommendations as to the arrangement of the mass of stone above low water. Yet the breakwater has resisted every storm which has yet spent itself upon it; and if occasionally a block of considerable dimensions has been moved from its place, it has been where entirely disconnected from the mass of the work, and generally in unfinished portions, over which the sea swept with all its violence.

I consider the width of 22 feet on the top to be quite unnecessary, even with the present shapeless materials and rude construction; and, with a proper modification of the mode of construction, I believe it could be reduced to twelve. Should I have any voice in the future arrangement of the work, I should urge that from the extreme low-water line the work should consist of dimension stones, carefully laid in courses of headers to the sea, having dimensions of at least 9 feet in length, and 2 by 3 on the head, and that the top should be capped with stone 12 feet in length, or covering the whole width. Such blocks would, even if isolated, be able to maintain their stability when thus placed lengthwise to the sea.

The interior slope from summit to low-water line may be but half base to one height, and the faces of the exterior may be adopted and roughly cut to Colonel Emory's curve, or any other profile adopted. The advantages of this profile and plan of construction are, that while equal stability and greater permanence of outline, and some approach to symmetry is obtained, one half of the useless mass of loose stone now made use of merely to *support* the real resisting portions of the structure may be dispensed with.

I believe that dimension stone, such as I have described, may now be obtained from the east at prices per ton not much exceeding what has been usually paid for shapeless blocks of over two tons; but even if they cost double those prices, the economy resulting from their use would not fail to be very great, and a structure would be made of symmetrical shape and workman-like appearance, instead of the present amorphous mass.

I shall not attempt a minute estimate on a project of which (if thought worthy of adoption) the details yet remain to be fixed, but shall nevertheless state my belief, that the breakwater may be completed according to the least costly plan, of closing the gap, for $500,000, and according to plan of a detached work, for $750,000; and I recommend that, before the application of any expenditure to the *extension* of the existing work, the matter should be referred to a board of officers.

In making this recommendation, however, I desire to be distinctly understood that there is no question whatever as to the expediency or practicability of improving the harbor, and in a great degree remedy-

ing its present deficiencies by one or the other of the three projects enumerated, but that it is important that neither one should be adopted without thorough investigation and discussion by engineers of experience; and I have no hesitation in expressing the belief that, whichever plan be adopted, the work may be completed for the last mentioned sum, viz: $750,000.

I therefore most urgently recommend that the sum of $300,000 be appropriated to be applied during the remaining portion of the current fiscal year, and during the year ending June 30, 1855, towards the immediate completion of this work, as a measure which the government owes to its commercial and shipping interests, to the protection of the lives of its seamen, and to the credit of the nation.

One hundred thousand dollars of the above would be applied at the opening of the season, in the spring of 1854, to raising the existing structure to its intended height, and in providing machinery for the further continuance of the work; and the balance as soon as the plan of extension was decided upon, and between that and the 30th June, 1855. * * * * * *

Respectfully submitted.

J. G. BARNARD,
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